# 1999
# AMENDMENTS
# to the
# Program of Studies: Junior High Schools

1. **Replace** front-end pages i to iv and Preamble pages 1 to 6 with **revised** front-end pages i to iv and Preamble pages 1 to 6.

2. MATHEMATICS: **Replace** Mathematics page 1 with Mathematics pages 1 to 33.

**Note**: No changes have been made in the Grade 7 to Grade 9 program.

However, copy of the mathematics program of studies implemented for:

- Grade 7 and 9, September 1996
- Grade 8, September 1997

is now being provided with these 1999 amendments.

# PROGRAM *of* STUDIES

## *Junior High Schools*

This Program of Studies is issued under the authority of the Minister of Learning pursuant to section 25(1) of the *School Act*, Statutes of Alberta, 1988, Chapter S–3.1 with amendments in force as of March 26, 1998.

Alberta
LEARNING

This document reflects changes in the program of studies for junior high schools up to June 1999.

Outside Edmonton dial 310–0000 for toll-free connection. Inside Edmonton dial 422–4872.

# PROGRAM OF STUDIES: JUNIOR HIGH

## 1999 CONTENTS



| Course<br>**All programs of study are available for viewing and downloading at <http://ednet.edc.gov.ab.ca>.** | A.<br>Program Rationale and Philosophy | B.<br>General Learner Expectations | C.<br>Curriculum Standards/ Specific Learner Expectations |
|---|---|---|---|
| HEALTH AND PERSONAL LIFE SKILLS | 1987 | B1–B2 1987<br>B3 1989 | C1 1989<br>C2 1987<br>C3–C5 1989 |
| LANGUAGE ARTS | | | |
| Language Arts | 1984 | 1984 | 1987 |
| Ukrainian Language Arts | 1990 | 1990 | 1990 |
| MATHEMATICS | | | |
| Grade 7 | 1996 | 1996 | 1996 |
| Grade 8 | 1997 | 1997 | 1997 |
| Grade 9 | 1996 | 1996 | 1996 |
| PHYSICAL EDUCATION | 1988 | 1988 | 1988<br>C2 1995 |
| SCIENCE | 1990 | 1990 | 1990 |
| SOCIAL STUDIES | 1989 | 1989 | 1989<br>C22–C23 1993 |
| CAREER AND TECHNOLOGY STUDIES | | | |
| Career and Technology Studies | 1997❶ | | |
| Career and Technology Studies [applies to all 22 strands] | 1999 | | |
| Agriculture | 1997 | 1997 | |
| Career Transitions | 1999 | 1999 | |
| Communication Technology | 1999 | 1999 | |
| Community Health | 1997 | 1997 | |
| Construction Technologies | 1997 | 1997<br>pp. 11, 18 1998 | |
| Cosmetology Studies | 1997 | 1997 | |
| Design Studies | 1997 | 1997 | |
| Electro-Technologies | 1997 | 1997 | |
| Energy and Mines | 1997 | 1997 | |
| Enterprise and Innovation | 1997 | 1997 | |
| Fabrication Studies | 1997 | 1997 | |
| Fashion Studies | 1997 | 1997 | |
| Financial Management | 1997 | 1997 | |
| Foods | 1997 | 1997 | |
| Forestry | 1999 | 1999 | |
| Information Processing | 1999 | 1999 | |
| Legal Studies | 1997 | 1997 | |
| Logistics | 1997 | 1997 | |
| Management and Marketing | 1999 | 1999 | |
| Mechanics | 1997 | 1997<br>pp. 11, 21, 34 1998 | |
| Tourism Studies | 1997 | 1997 | |
| Wildlife | 1997 | 1997 | |

The dates in the grid indicate the most current and up-to-date sections in each program of studies.

❶ Program information only.

| Course<br>**All programs of study are available for viewing and downloading at <http://ednet.ede.gov.ab.ca>.** | A.<br>Program Rationale and Philosophy | B.<br>General Learner Expectations | C.<br>Curriculum Standards/ Specific Learner Expectations |
|---|---|---|---|
| ENVIRONMENTAL AND OUTDOOR EDUCATION | 1990 | 1990 | 1990 |
| FINE AND PERFORMING ARTS | | | |
| Art | 1984 | 1984 | 1984 |
| Drama | 1989 | 1989 | 1989 |
| Music | 1988 | 1988 | 1988 |
| INTEGRATED OCCUPATIONAL PROGRAM | | | |
| English Language Arts | 1992 | 1992 | 1992 |
| Practical Arts/Occupational Component | 1992 | 1992 | 1992 |
| Social Studies | 1992 | 1992 | 1992 |
| Mathematics<br>Science | Copies of the interim 1992 programs of study are available for purchase from the Learning Resources Distributing Centre. | | |
| NATIVE LANGUAGES | | | |
| Blackfoot Language and Culture Program | 1990 | 1990 | 1990 |
| Cree Language and Culture Program | 1989 | 1989 | 1989 |
| RELIGIOUS OR ETHICAL STUDIES | | | |
| Ethics | 1989 | 1989 | 1989 |
| SECOND LANGUAGES | | | |
| French as a Second Language | 1992 | | |
| Beginning Level | | 1992 | 1992 |
| Intermediate Level | | 1993 | 1993 |
| German as a Second Language | 1984 | 1984 | 1984 |
| Ukrainian as a Second Language | 1984 | 1984 | 1984 |

 

# INTRODUCTION

## Program of Studies

The *Program of Studies* identifies the expectations for the core and optional learning components for Kindergarten to Grade 12. Content is focused on what students are expected to know and be able to do.

Though organized into separate subject, course or program areas, there are many connections across the curriculum. Students see the world as a connected whole rather than as isolated segments. Integrating across content areas, and providing ways for students to make connections, enhances student learning. The reporting of student progress should, nevertheless, be in terms of the expectations outlined in courses of study for each subject area.

Within any group of students there is a range of individual differences. Flexibility in planning for individuals within a group is needed. Therefore, school organization and teacher methodology are not mandated at the provincial level and may vary from class to class and school to school in order to meet student needs.

For guidelines and regulations relating to school programs and organization for instruction, refer to the *Guide to Education: ECS to Grade 12*, available for viewing and downloading from the Internet. Print copies are available for purchase from the LRDC.

## Basic Learning Resources

Alberta Learning authorizes a variety of resources to support the programs of study. Complete listings of all resources are to be found in the Learning Resources Distributing Centre (LRDC) *Buyers Guide*, or electronically through the:

- LRDC Internet web site at <http://www.lrdc.edc.gov.ab.ca>.

Resource listings can also be accessed through the:

- Authorized Resources Database at <http://ednet.edc.gov.ab.ca> under Students and Learning, Learning and Teaching Resources.

## Internet Site

Information covering all areas of Kindergarten to Grade 12 education in Alberta, including curriculum and resources, can be found at <http://ednet.edc.gov.ab.ca>.

Information on-site is organized into sections focusing on Students and Learning; Parents; Teaching; Funding; Education System; and Technology.

# PROGRAM FOUNDATIONS: VISION, MISSION AND PRINCIPLES, AND BASIC EDUCATION★

## Vision for Education

Alberta's young people are the best educated in the country, able to achieve their individual potential, create a positive future for themselves, their families and their communities, and contribute to Alberta's prosperity and superior quality of life.

## Mission

To ensure that all Alberta students have the opportunity to acquire the knowledge, skills and attitudes needed to be self-reliant, responsible, caring and contributing members of society.

## Principles

The *School Act* provides the legislative framework for sustaining and developing Alberta's education system. Students are the focus of the act, which is based on a set of five underlying principles.

- *Access to quality education*: Every student in Alberta has the right of access to a quality basic education which is consistent with the student's abilities and provides the necessary knowledge, skills and attitudes to fulfill personal goals and contribute to society as a whole.
- *Equity*: All students in Alberta must have access to a quality basic education regardless of where in the province they live.
- *Flexibility*: Within standards and policies set by the provincial government, there are opportunities for parent and student choice in the public education system. School boards, schools and individual teachers have flexibility to meet the educational needs of the students and communities they serve.
- *Responsiveness*: The student is the focus of all activities in the education system: legislation, policies and practices affecting all levels must support the efforts of communities to ensure school programs and services respond to the unique needs of each child.
- *Accountability*: All those involved in making decisions about educational matters, including the allocation of public funds for education, must be accountable for their decisions, choices and results. This includes the Minister of Learning, school boards and their staff, parents as well as students.

Guided by these principles, the three-year plan for education annually outlines improvements and directions for the education system consistent with the *School Act* (Statutes of Alberta, 1988, Chapter S–3.1 as amended, section 60.2, subsections 1 to 3).

## Basic Education in Alberta—the Definition

A basic education must provide students with a solid core program, including language arts, mathematics, science and social studies. Students will be able to meet the provincial graduation requirements and be prepared for entry into the workplace or post-secondary studies. Students will understand personal and community values and the rights and responsibilities of citizenship. Students will develop the capacity to pursue learning throughout their lives. Students also should have opportunities to learn languages other than English and to attain levels of proficiency and cultural awareness which will help to prepare them for participation in the global economy.

---

★ Excerpted from *First Things First Our Children: The Government of Alberta's Three-year Plan for Education, 1999 2000 to 2001 2002*. The plan is available from the Communications Branch or can be found at <http://ednet.edc.gov.ab.ca>. Basic Education in Alberta—the Definition is contained in Ministerial Order Number 004/98 rather than in the three-year education plan.

 

**Student Learning Outcomes**

Students are expected to develop the knowledge, skills and attitudes that will prepare them for life after high school. A basic education will allow students to:

- read for information, understanding and enjoyment
- write and speak clearly, accurately and appropriately for the context
- use mathematics to solve problems in business, science and daily-life situations
- understand the physical world, ecology and the diversity of life
- understand the scientific method, the nature of science and technology, and their application to daily life
- know the history and geography of Canada and have a general understanding of world history and geography
- understand Canada's political, social and economic systems within a global context
- respect the cultural diversity and common values of Canada
- demonstrate desirable personal characteristics, such as respect, responsibility, fairness, honesty, caring, loyalty and commitment to democratic ideals
- recognize the importance of personal well-being, and appreciate how family and others contribute to that well-being
- know the basic requirements of an active, healthful lifestyle
- understand and appreciate literature, the arts and the creative process
- research an issue thoroughly, and evaluate the credibility and reliability of information sources
- demonstrate critical and creative thinking skills in problem solving and decision making
- demonstrate competence in using information technologies
- know how to learn and work independently and as part of a team
- manage time and other resources needed to complete a task
- demonstrate initiative, leadership, flexibility and persistence
- evaluate their own endeavours and continually strive to improve
- have the desire and realize the need for lifelong learning.

**Standards for Student Learning**

The Minister of Learning defines acceptable standards and standards of excellence for student achievement in consultation with Albertans. Employers are involved in specifying the knowledge, skills and attitudes needed in the workplace. Schools, school authorities and the Minister of Learning assess and report regularly to the public on a range of student learning.

The school's primary responsibility is to ensure that students meet or exceed the provincial standards, as reflected in the Student Learning Outcomes (outlined above), the Alberta Programs of Study, provincial achievement tests, diploma examinations and graduation requirements.

**Education Delivery**

Schools must engage students in a variety of activities that enable them to acquire the expected learnings. Schools have authority to deploy resources and may use any instructional technique acceptable to the community as long as the standards are achieved. Schools, teachers and students are encouraged to take advantage of various delivery options, including the use of technology, distance learning and the workplace.

Schools play a supportive role to families and the community in helping students develop desirable personal characteristics and the ability to make ethical decisions. Schools also help students take increasing responsibility for their learning and behaviour, develop a sense of community belonging and acquire a clearer understanding of community values and how these relate to personal values.

Students learn basic, transferable knowledge, skills and attitudes in school. Schools, in co-operation with employers, provide opportunities for students to develop and practise

employability skills. The Minister of Learning provides credit for off-campus learning that is approved and accepted by the school and the employer. Government works with schools, employers and post-secondary institutions to help young people make a smooth transition to work and further study.

## RELIGIOUS AND PATRIOTIC INSTRUCTION

The following section of the *School Act* focuses on religious and patriotic instruction. It is cited here for the information of teachers and administrators.

SECTION 33(1) A board may

(a) prescribe religious instruction to be offered to its students;

(b) prescribe religious exercises for its students;

(c) prescribe patriotic instruction to be offered to its students;

(d) prescribe patriotic exercises for its students;

(e) permit persons other than teachers to provide religious instruction to its students.

(2) Where a teacher or other person providing religious or patriotic instruction receives a written request signed by a parent of a student that the student be excluded from religious or patriotic instruction or exercises, or both, the teacher or other person shall permit the student

(a) to leave the classroom or place where the instruction or exercises are taking place for the duration of the instruction or exercises, or

(b) to remain in the classroom or place without taking part in the instruction or exercises.

1988 cS–3.1 s33;1990 c36 s16

 

# LEARNING RESOURCES

## POLICY

Alberta Learning selects, acquires, develops, produces, translates and authorizes the best possible instructional materials for the implementation of approved programs of study.

## LEARNING RESOURCE CATEGORIES

In terms of provincial policy, learning resources are those print, nonprint and electronic software materials used by teachers or students to facilitate teaching and learning. Many learning resources, both publisher-developed and teacher-made, are available for use in implementing elementary, junior high and senior high programs. Decisions about the selection and use of resources are a local matter and should take into account the student skill levels, interests, motivations and stages of development.

Alberta Learning authorizes learning resources in three categories:

- basic student learning resources
- support student learning resources
- authorized teaching resources.

Authorization indicates that the resources meet high standards and can contribute to the attainment of the goals of the program. However, the authorization of resources does not require their use in program delivery. Under section 44 (2) of the *School Act*, school boards may approve materials for their schools, including resources that are withdrawn from the provincial list. Many school boards have delegated this power to approve resources to school staff or other board employees under section 45 (1) of the *School Act*.

### Basic Student Learning Resources

Basic learning resources are those student learning resources authorized by Alberta Learning as the most appropriate for addressing the majority of learner expectations of the course(s), substantial components of the course(s), or the most appropriate for meeting general learner expectations across two or more grade levels, subject areas or programs as outlined in provincial programs of study. These may include any resource format, such as print, nonprint, computer software, manipulatives or video.

In exceptional circumstances, a teacher resource may be given basic status.

### Support Student Learning Resources

Support learning resources are those student learning resources authorized by Alberta Learning to assist in addressing some of the learner expectations of course(s) or components of course(s); or to assist in meeting the learner expectations across two or more grade levels, subject areas or programs as outlined in the provincial programs of study. These may include any resource format, such as print, nonprint, computer software, manipulatives or video.

### Authorized Teaching Resources

Authorized teaching resources are those teaching resources produced externally to Alberta Learning (for example, by publishers) that have been reviewed by Alberta Learning, found to meet the criteria of review and to be the best available resources to support the implementation of programs of study and courses, and the attainment of the goals of education; they have been authorized by the Minister. Teaching resources produced as service documents by Alberta Learning are authorized by definition.

## AVAILABILITY

Most authorized resources are available for purchase from the Learning Resources Distributing Centre (LRDC), 12360 – 142 Street, Edmonton, Alberta, Canada, T5L 4X9. Telephone 403–427–5775, Fax 403–422–9750, Internet <http://www.lrdc.edc.gov.ab.ca>.

Resources are listed in the Learning Resources Distributing Centre *Buyers Guide* and at the LRDC web site. Resources are also listed in the Authorized Resources Database at <http://ednet.edc.gov.ab.ca> under Students and Learning, Learning and Teaching Resources.

 

# MATHEMATICS GRADES 7–8–9

## INTRODUCTION

The Mathematics 7–8–9 program of studies has been derived from *The Common Curriculum Framework for K–12 Mathematics: Western Canadian Protocol for Collaboration in Basic Education,* 1995 (the Common Curriculum Framework). The program of studies incorporates the conceptual framework for Kindergarten to Grade 12 mathematics and the general outcomes and specific outcomes that were established in the Common Curriculum Framework. The implementation dates for the Mathematics 7–8–9 program were:

- Grade 7 and Grade 9 in September 1996
- Grade 8 in September 1997.

## BACKGROUND

The Common Curriculum Framework was developed as a part of the Western Canadian Protocol for Collaboration in Basic Education Kindergarten to Grade 12, which was signed by the ministers of education from Alberta, British Columbia, Manitoba, Saskatchewan, Northwest Territories and the Yukon Territory.

The Common Curriculum Framework was developed to provide a common base for the curriculum expectations mandated by each province and territory. This common base will result in consistent student outcomes in mathematics across jurisdictions and will enable easier transfer for students moving from one jurisdiction to another. The intent of the Common Curriculum Framework was to **communicate clearly high expectations for students in mathematics education to all educational partners across the jurisdictions** and facilitate the development of common learning resources.

## BELIEFS ABOUT STUDENTS AND MATHEMATICS LEARNING

Students are curious, active learners who have individual interests, abilities and needs. They come to classrooms with different knowledge, life experiences and backgrounds that generate a range of attitudes about mathematics and life.

Students learn by attaching meaning to what they do; and they must be able to construct their own meaning of mathematics. This meaning is best developed when learners encounter mathematical experiences that proceed from the simple to the complex and from the concrete to the abstract. The use of manipulatives can address the diversity of learning styles and developmental stages of students and can enhance the formation of sound, transferable, mathematical concepts. At all levels, students benefit from working with appropriate materials, tools and contexts when constructing personal meaning about new mathematical ideas. The learning environment should value and respect each student's way of thinking, so that the learner feels comfortable in taking intellectual risks, asking questions and posing conjectures.

Mathematics is a common human activity, increasing in importance in a rapidly advancing, technological society. A greater proficiency in using mathematics increases the opportunities available to individuals. Students need to become mathematically literate in order to explore problem-solving situations, accommodate changing conditions, and actively create new knowledge in striving for self-fulfillment.

## GOALS FOR STUDENTS

The main goals of mathematics education are to prepare students to:

- use mathematics confidently to solve problems
- communicate and reason mathematically
- appreciate and value mathematics
- commit themselves to lifelong learning
- become mathematically literate adults, using mathematics to contribute to society.

At the completion of a program, students should have developed a positive attitude toward mathematics and have a base of knowledge and skills related to Number, Patterns and Relations, Shape and Space, and Statistics and Probability.

It is important for students to develop a positive attitude toward mathematics so that they can become confident in their ability to undertake the problems of a changing world, thereby experiencing the power and usefulness of mathematics. Students also should gain an understanding and appreciation of the contributions of mathematics, as a science and as an art, to civilization and to culture.

Students should:

- exhibit a positive attitude toward mathematics
- engage and persevere in mathematical tasks and projects
- contribute to mathematical discussions
- take risks in performing mathematical tasks
- exhibit curiosity
- show some enjoyment of mathematical experiences.

All students should receive a level of mathematics education appropriate to their needs and abilities.

## CONCEPTUAL FRAMEWORK FOR K–12 MATHEMATICS

Students of mathematics, regardless of age or experience, struggle to do mathematics in settings that are new to them. The conceptual framework outlined in this section presents a multifaceted view of mathematics and presents the discipline as skills, procedures and concepts woven together.

The framework chart below shows how student outcomes, organized by strand, and within a grade, are designed to be influenced by Mathematical Processes and the Nature of Mathematics. These components are described more fully in this section.

| STRAND | Kindergarten to Grade 12 | |
|---|---|---|
| **Number**<br>• Number Concepts<br>• Number Operations<br>**Patterns and Relations**<br>• Patterns<br>• Variables and Equations<br>• Relations and Functions<br>**Shape and Space**<br>• Measurement<br>• 3-D Objects and 2-D Shapes<br>• Transformations<br>**Statistics and Probability**<br>• Data Analysis<br>• Chance and Uncertainty | **GENERAL AND SPECIFIC OUTCOMES** ★<br>**to**<br>**Outline Knowledge, Skills and Attitudes about Mathematics** | **NATURE OF MATHEMATICS**<br>**Change, Constancy, Dimension (size and scale), Number, Pattern, Quantity, Relationships, Shape, Uncertainty** |

**MATHEMATICAL PROCESSES – COMMUNICATION, CONNECTIONS, ESTIMATION AND MENTAL MATHEMATICS, PROBLEM SOLVING, REASONING, TECHNOLOGY, VISUALIZATION**

★ Illustrative examples for the prescribed program of studies outcomes are provided in the companion document *Alberta Program of Studies for K–9 Mathematics: Western Canadian Protocol for Collaboration in Basic Education*, released in June 1996.

## MATHEMATICAL PROCESSES

There are critical components that students must encounter in a mathematics program in order to achieve the goals of mathematics education and to encourage lifelong learning in mathematics. Students are expected to:

| | |
|---|---|
| *Communication* [C] | • communicate mathematically |
| *Connections* [CN] | • connect mathematical ideas to other concepts in mathematics, to everyday experiences and to other disciplines |
| *Estimation and Mental Mathematics* [E] | • use estimation and mental mathematics where appropriate |
| *Problem Solving* [PS] | • relate and apply new mathematical knowledge through problem solving |
| *Reasoning* [R] | • reason and justify their thinking |
| *Technology* [T] | • select and use appropriate technologies as tools to solve problems |
| *Visualization* [V] | • use visualization to assist in processing information, making connections and solving problems. |

The Mathematics 7–8–9 program of studies incorporates these seven interrelated mathematical processes that are intended to permeate teaching and learning.

**Communication**

Students need to communicate mathematical ideas clearly and effectively, orally and in writing.

Communication will help students make connections among different representations of mathematical ideas; namely, "physical, pictorial, graphic, symbolic, verbal and mental representations." (NCTM, p. 26)

It is not enough to arrive at an answer. Students must be able to communicate effectively how the answer was obtained. In other words, students need opportunities to read, to explore, to investigate, to write, to listen to, to discuss and to explain ideas in their own language of mathematics. Thus, students can create their own links "between their informal, intuitive notions and the abstract language and symbolism of mathematics." (NCTM, p. 26)

**NCTM COMMUNICATION STANDARDS**

| K–4 | 5–8 | 9–12 |
|---|---|---|
| *The study of mathematics should include numerous opportunities for communication so that students can:* | *The study of mathematics should include opportunities to communicate so that students can:* | *The mathematics curriculum should include the continued development of language and symbolism to communicate mathematical ideas so that all students can:* |
| • relate physical materials, pictures, and diagrams to mathematical ideas<br>• reflect on and clarify their thinking about mathematical ideas and situations<br>• relate their everyday language to mathematical language and symbols<br>• realize that representing, discussing, reading, writing, and listening to mathematics are a vital part of learning and using mathematics. | • model situations using oral, written, concrete, pictorial, graphical, and algebraic methods<br>• reflect on and clarify their own thinking about mathematical ideas and situations<br>• develop common understandings of mathematical ideas, including the role of definitions<br>• use the skills of reading, listening, and viewing to interpret and evaluate mathematical ideas<br>• discuss mathematical ideas and make conjectures and convincing arguments<br>• appreciate the value of mathematical notation and its role in the development of mathematical ideas. | • reflect upon and clarify their thinking about mathematical ideas and relationships<br>• formulate mathematical definitions and express generalizations discovered through investigations<br>• express mathematical ideas orally and in writing<br>• read written presentations of mathematics with understanding<br>• ask clarifying and extending questions related to mathematics they have read or heard about<br>• appreciate the economy, power, and elegance of mathematical notation and its role in the development of mathematical ideas. |
| (NCTM, p. 26) | (NCTM, p. 78) | (NCTM, p. 140) |

### Connections

Students need numerous and varied experiences in order to appreciate the usefulness of mathematics and, at the same time, to explore connections within mathematics, from mathematics to other disciplines, and from mathematics to their daily experiences. When mathematical ideas are connected to each other through concrete, pictorial and symbolic representations, students begin to view mathematics as an integrated whole.

This integration "allows students to see how one mathematical idea can help them understand others, and it illustrates the subject's usefulness in solving problems, describing and modeling real-world phenomena, and communicating complex thoughts and information in a concise and precise manner." (NCTM, p. 94)

**NCTM CONNECTIONS STANDARDS**

| K–4 | 5–8 | 9–12 |
|---|---|---|
| *The study of mathematics should include opportunities to make connections so that students can:* | *The mathematics curriculum should include the investigation of mathematical connections so that students can:* | *The mathematics curriculum should include investigation of the connections and interplay among various mathematical topics and their applications so that all students can:* |
| • link conceptual and procedural knowledge<br>• relate various representations of concepts or procedures to one another<br>• recognize relationships among different topics in mathematics<br>• use mathematics in other curriculum areas<br>• use mathematics in their daily lives. | • see mathematics as an integrated whole<br>• explore problems and describe results using graphical, numerical, physical, algebraic, and verbal mathematical models or representations<br>• use a mathematical idea to further their understanding of other mathematical ideas<br>• apply mathematical thinking and modeling to solve problems that arise in other disciplines, such as art, music, psychology, science, and business<br>• value the role of mathematics in our culture and society. | • recognize equivalent representations of the same concept<br>• relate procedures in one representation to procedures in an equivalent representation<br>• use and value the connections among mathematical topics<br>• use and value the connections between mathematics and other disciplines. |
| (NCTM, p. 32) | (NCTM, p. 84) | (NCTM, p. 146) |

### Estimation and Mental Mathematics

Students need to know when and how to estimate. The context of a problem helps to determine when it is necessary or desirable to have an exact answer or an estimate of that answer. Problem contexts include number, patterns and relations, shape and space, and statistics and probability. The use of technology increases the emphasis on estimation skills to enable students to determine the reasonableness of computed answers.

A variety of estimation strategies assists students in arriving at quick approximations for exact answers.

Facility with mental mathematics is an important outcome for students. A focus on mental mathematics forces students to think and improve their efficiency and accuracy in calculating, including pencil and paper calculations. Mental mathematics is the cornerstone for estimation and leads to better understanding of number concepts and number operations. (Hope, pp. 161–173)

**Problem Solving**

*"Problem solving—which includes the ways in which problems are represented, the meanings of the language of mathematics, and the ways in which one conjectures and reasons—must be central to schooling so that students can explore, create, accommodate to changed conditions, and actively create new knowledge over the course of their lives."* (NCTM, p. 4)

Problem solving is the focus of mathematics at all grade levels. The development of each student's ability to solve problems is essential. Students develop a true understanding of mathematical concepts and procedures when they solve problems in meaningful contexts. Problem solving is to be employed throughout all of mathematics and should be embedded throughout all of the strands.

Problem solving provides an opportunity for students to be active in constructing mathematical meaning, to learn problem-solving strategies, to practise a variety of concepts and skills in a meaningful context, and to communicate mathematical ideas. Most problem-solving situations in the elementary years come from the everyday experiences of students. Students are able to attach mathematical meaning to familiar activities. As they progress through school, the problems become more complex. The problems will arise from an exploration of mathematics itself, as well as from the world around them. Gradually, students become more confident in their ability to use and communicate mathematics, using correct terminology.

As students develop mathematically, they are able to solve more challenging problems on an increasing variety of topics. Students need the opportunity "to solve problems that require them to work cooperatively (and individually), to use technology, to address relevant and interesting mathematical ideas, and to experience the power and usefulness of mathematics." (NCTM, pp. 75–76) By the time students reach the secondary level, many problem-solving strategies should be internalized and problem solving should be a process for constructing and reinforcing mathematical concepts.

Students should be confident and flexible problem solvers, using a wide range of strategies in their work, and accept that some problems have different solutions.

**NCTM PROBLEM-SOLVING STANDARDS**

| K–4 | 5–8 | 9–12 |
|---|---|---|
| *The study of mathematics should emphasize problem solving so that students can:* | *The mathematics curriculum should include numerous and varied experiences with problem solving as a method of inquiry and application so that students can:* | *The mathematics curriculum should include the refinement and extension of methods of mathematical problem solving so that all students can:* |
| • use problem-solving approaches to investigate and understand mathematical content<br>• formulate problems from everyday and mathematical situations<br>• develop and apply strategies to solve a wide variety of problems<br>• verify and interpret results with respect to the original problem<br>• acquire confidence in using mathematics meaningfully. | • use problem-solving approaches to investigate and understand mathematical content<br>• formulate problems from situations within and outside mathematics<br>• develop and apply a variety of strategies to solve problems, with emphasis on multistep and nonroutine problems<br>• verify and interpret results with respect to the original problem situation<br>• generalize solutions and strategies to new problem situations<br>• acquire confidence in using mathematics meaningfully. | • use, with increasing confidence, problem-solving approaches to investigate and understand mathematical content<br>• apply integrated mathematical problem-solving strategies to solve problems from within and outside mathematics<br>• recognize and formulate problems from situations within and outside mathematics<br>• apply the process of mathematical modeling to real-world problem situations. |
| (NCTM, p. 23) | (NCTM, p. 75) | (NCTM, p. 137) |

## Reasoning

Students need to develop confidence in their ability to reason and to justify their thinking within and outside of mathematics. The power of reasoning helps students to make sense of mathematics, to be logical in their thinking, and to convince others.

Inductive reasoning helps students explore and make conjectures from activities that allow generalizations from a pattern of observations.

Deductive reasoning helps students test conjectures and build arguments that serve to validate thinking. Deductive reasoning builds a structured body of knowledge.

**NCTM REASONING STANDARDS**

| K–4 | 5–8 | 9–12 |
|---|---|---|
| *The study of mathematics should emphasize reasoning so that students can:* | *Reasoning shall permeate the mathematics curriculum so that students can:* | *The mathematics curriculum should include numerous and varied experiences that reinforce and extend logical reasoning skills so that all students can:* |
| • draw logical conclusions about mathematics<br>• use models, known facts, properties, and relationships to explain their thinking<br>• justify their answers and solution processes<br>• use patterns and relationships to analyze mathematical situations<br>• believe that mathematics makes sense. | • recognize and apply deductive and inductive reasoning<br>• understand and apply reasoning processes, with special attention to spatial reasoning and reasoning with proportions and graphs<br>• make and evaluate mathematical conjectures and arguments<br>• validate their own thinking<br>• appreciate the pervasive use and power of reasoning as a part of mathematics. | • make and test conjectures<br>• formulate counterexamples<br>• follow logical arguments<br>• judge the validity of arguments<br>• construct simple valid arguments. |
| (NCTM, p. 29) | (NCTM, p. 81) | (NCTM, p. 143) |

## Technology

Improvements in technology, and its increased availability in schools, have changed the focus of mathematics education. The time saved by using calculators or computers to perform complex calculations can be used to help students better understand mathematical concepts. Students can then understand the relationships among concepts and use these relationships to solve problems.

Calculators and computers can be used as tools to:

- develop concepts
- explore and demonstrate mathematical relationships and patterns
- organize and display data
- assist with solving problems and thus promote independence
- encourage students to be inquisitive and creative
- decrease the time spent on tedious computations
- reinforce the learning of basic number facts and properties
- develop an understanding of computational algorithms
- create geometric displays
- simulate situations.

In some cases, technology will allow teachers to ask questions requiring a high level of thinking and will allow students to solve complex, multifaceted problems. Technology can foster environments in which the growing curiosity of students can lead to rich mathematical discoveries. In these environments, the control of exploring mathematical ideas can be turned over to students.

**Visualization**

*Images are useful in describing the physical and mathematical environment.*

Visualization "involves thinking in *pictures* and *images* and the ability to perceive, transform and re-create different aspects of the visual–spatial world." (Armstrong, p. 10, italics in original) The use of images in the study of mathematics provides students with the opportunity to understand mathematical concepts and to make connections among them.

The physical environment is full of images. The images are of 3-D objects, 2-D shapes, 1-D lines and pictures. In geometry, the study of a 3-D object is assisted by visualizing either the net of 2-D shapes or the skeleton of 1-D lines required to construct the object.

The mathematical environment is full of images. These images are used to communicate mathematical concepts and multiple solutions to problems. At an elementary level, four piles, each containing three coins, can be used to represent $3 + 3 + 3 + 3 = 12$. Rearranging the piles into four rows of 3 can then be used to represent $4 \times 3 = 12$. Connecting the two images links the process of multiplication with that of repeated addition. At a more advanced level, analytic geometry describes figures algebraically and provides a tool for the visualization of algebraic relations. The analysis and interpretation of data using a visual summary aids in understanding the data and making predictions from it.

## NATURE OF MATHEMATICS

- *Change*
- *Constancy*
- *Dimension*
- *Number*
- *Pattern*
- *Quantity*
- *Relationships*
- *Shape*
- *Uncertainty*

By enriching our view of mathematics and the learning environment, the outcomes of this program of studies can be accomplished.

The brain is constantly looking for and making connections. "Because the learner is constantly searching for connections on many levels, educators need to orchestrate the experiences from which learners extract understanding. . . . Brain research establishes and confirms that multiple complex and concrete experiences are essential for meaningful learning and teaching." (Caine, p. 5)

There are additional critical components that must be addressed in a mathematics program beyond those listed as mathematical processes. The components discussed are: Change, Constancy, Dimension (size and scale), Number, Pattern, Quantity, Relationships, Shape and Uncertainty. They are used to describe mathematics in a broad way in order to establish the wide variety of connections that can be made among the various strands used to organize the outcomes central to this program of studies.

**Change**

Change can be discussed from Kindergarten to Grade 12 across many aspects of mathematics. The study of change is often discussed in the context of calculus, and is often limited to this context. However, change is a much broader concept than that used in calculus. In order to make predictions, students need to describe and quantify their observations, attempt to build patterns, and identify those quantities that remain fixed and those quantities that change. For example, look at the pattern 4, 6, 8, 10, 12, . . . An elementary school student can describe this as skip counting by 2s, starting from 4. A senior high school student may describe this pattern as an arithmetic sequence, with first term 4, and a common difference of 2. Another student may describe it as a linear function with a discrete domain. All three interpretations are focusing on the changing size of the numbers within the sequence. To be able to understand change, students must become sensitive to patterns, such

as linear, exponential, logarithmic and periodic. (Steen, p. 184)

**Constancy**

Students are expected to communicate ideas visually, using diagrams and oral and written words, when describing constancy or invariance. Different aspects of constancy "are described by the terms stability, conservation, equilibrium, steady state, and symmetry." (AAAS–Benchmarks, p. 270) The most important properties in mathematics and science relate to those properties that do not change when outside conditions change. Elementary school students deal with constancy in situations where different methods are used to solve a single multiplication problem, such as finding the area of a 3-tile by 4-tile tabletop. Secondary students need to deal with constancy when they solve the more complicated multiplication problems that appear in determining the number of elements present in the sample spaces of probability problems. Many of these situations will involve permutations and combinations.

In geometry, a circle can be transformed into an ellipse by a simple stretch, and into a square by a more complex series of transformations; but there is no way that the circle can be transformed into a parabola. The closed figures, such as circles and squares, remain closed and cannot be transformed into open figures, such as parabolas. Triangles can be distorted in many ways, but all will have an angle sum of 180°. The straight line is characterized as having all its parts with the same slope. In solving many of the most important problems in mathematics, students need to concentrate on the properties that remain constant. This idea enables students to solve problems involving constant rates of change, lines with constant slope, direct variation situations, or the angle sums of polygons.

**Dimension (size and scale)**

The concept of dimension, most usually associated with 3-D objects, 2-D figures or 1-D lines, needs to be developed within an environment of physical objects for all grades from Kindergarten to Grade 12. The prediction of the change in dimension of objects can be done using numbers attached to appropriate units. For example, with no knowledge of a formula, students in upper elementary grades can predict that doubling the side of a square generates four times the area. Junior and senior high school students need to be able to use algebraic structures to formalize this relationship.

Physical objects can all be described using measurement concepts. The development of perimeter, area and volume concepts relies on pattern recognition, not on memorization of formulas. Descriptions of geometric patterns (number of vertices, sides and edges of various 3-D objects, 2-D figures and 1-D lines); and the angle sum of various 2-D figures is also encouraged. This type of data should be placed in charts and/or graphs to help students visualize their findings and predict patterns.

**Number**

Number, number systems and the operations on numbers are vital to all mathematics learning. The use of number must go beyond procedure and accuracy to include what is called number sense. Number sense includes:

- an intuitive feeling about numbers and their multiple relationships
- construction of the meaning of number through a variety of experiences, and development of an appreciation of the need for numbers beyond whole numbers (NCTM, p. 38)
- an appreciation and ability to make quick order of magnitude approximations (Steen, p. 79) with emphasis on establishing quick and accurate estimations for computation and measurement
- the ability to detect arithmetic errors
- knowledge of place value and the effects of arithmetic operations.

Many numerical calculations are performed with calculators and computers, and students must be able to determine if the desired calculations have been done correctly. Students must plan for the efficient use of technological tools.

Number patterns should be recognized and used to count, to make predictions, to describe shapes and to compare.

**Pattern**

"What humans do with the language of mathematics is to describe patterns. Mathematics is an exploratory science that seeks to understand every kind of pattern. . . ." (Steen, p. 8) Patterns exist in number, geometry, algebra and data. By helping students recognize, extend, create and use patterns as a routine aspect of their lives, mathematics will become a useful tool to assist them in their systematic and intellectual understanding of their environment.

**Quantity**

"Quantitatively literate young need a flexible ability to identify critical relations in novel situations, to express these relations in effective symbolic form, to use computing tools to process information, and to interpret the results of those calculations." (Steen, p. 65)

Students have a strong desire to measure, code and order things. To this end, some of the outcomes are about single numbers, numbers attached to units of measure, and ordered sets of numbers. Other outcomes are about the interpretation of numbers and of number systems. The use of single numbers and of ordered pairs to describe phenomena in all aspects of mathematics, the natural sciences and the social sciences is very important.

With the growing use of technology to process numerical information, it is becoming essential for students to have a wide range of estimation skills so that they can evaluate whether or not the numerical output provided by a calculator or a computer is a reasonable solution to a given problem.

**Relationships**

The study of mathematics is the development of relationships between and among things. Part of mathematics should help students develop a sense of discovery that mathematicians over the years have felt and should prepare the way for students to make their own discoveries. Students should look for relationships among physical things, as well as the data used to describe those things. Descriptions of the attributes of objects are used to analyze symmetry and congruence and to classify things, using increasingly sophisticated language. Relationships will be described visually, symbolically, orally and in written form.

**Shape**

Shape in mathematics is central to geometry but also includes geometric representations of algebraic relations, the geometry of maps and the creation of networks of plane figures that can be used to construct 3-D objects. It is very important for students to look for and use similarities, congruences, patterns, transformations, dilatations and tessellations in the solution of a range of problems.

The use of language to describe shapes is an important aspect of mathematics. This description allows for the classification of objects according to various attributes, the naming of objects, and the analysis of objects. The study of shape can be used to build a deductive system, which can assist in further, more detailed analysis. Shape is used in the development of visual models in other disciplines, such as the use of molecular models in chemistry and biology.

The use of technology to analyze and depict shape will increase in importance for students of mathematics as more and better software and hardware become available in classrooms.

**Uncertainty**

Uncertainty involves data, chance, measurements and errors. Problems dealing with data, together with numbers in context found in the mass media, can be solved within the school mathematics program so long as the data provided and the problems posed have some meaning and relevance to students.

Chance deals with the predictable and the unpredictable outcomes of events. Students from an early age are expected to deal with the concept of chance. As they mature, the language they use to describe chance becomes more sophisticated and involves the vocabulary of probability theory.

When dealing with random events and complex experiments, students can generate large quantities of data requiring analysis. The use of various technologies enables the student to summarize data easily and to create a visualization of the data to help identify patterns in the information. In some instances the functions describing patterns are linear, periodic, logarithmic or exponential, and senior high school students are expected to use the appropriate algebraic structures to model the information contained within the pattern.

The quality of the output information is directly related to the quality of the input data. The study of uncertainty allows students to assess the reliability of input data, and to learn the processes whereby input data is converted to output information.

## STRANDS

- *Number*
- *Patterns and Relations*
- *Shape and Space*
- *Statistics and Probability*

The student outcomes are organized within four strands. The strands are the formal aspects of the discipline of mathematics that form the foundation of this program of studies and act as connections across the grades. Four strands have been identified for the entire Kindergarten to Grade 12 mathematics framework to reinforce the interrelationship of mathematical concepts and skills. These strands are split into substrands. However, any such grouping into strands and substrands is for organizational purposes only, and does not reflect the connections among the strands and the underlying themes running throughout all of mathematics.

### Number

Number Concepts

*Students will:*
- use numbers to describe quantities
- represent numbers in multiple ways.

Number Operations

*Students will:*
- demonstrate an understanding of and proficiency with calculations
- decide which arithmetic operation or operations can be used to solve a problem and then solve the problem.

### Patterns and Relations

Patterns

*Students will:*
- use patterns to describe the world and to solve problems.

Variables and Equations

*Students will:*
- represent algebraic expressions in multiple ways.

Relations and Functions
[applies to Grades 10–12]

*Students will:*
- use algebraic and graphical models to generalize patterns, make predictions and solve problems.

### Shape and Space

Measurement

*Students will:*
- describe and compare everyday phenomena, using either direct or indirect measurement.

3-D Objects and 2-D Shapes

*Students will:*

- describe the characteristics of 3-D objects and 2-D shapes, and analyze the relationships among them.

Transformations

*Students will:*

- perform, analyze and create transformations.

**Statistics and Probability**

Data Analysis

*Students will:*

- collect, display and analyze data to make predictions about a population.

Chance and Uncertainty

*Students will:*

- use experimental or theoretical probability to represent and solve problems involving uncertainty.

## STUDENT EXPECTATIONS

The content is stated in terms of outcomes. These outcomes are measurable and identify what students are expected to know and do.

The outcomes are stated by strand, and within a grade, and are based on the expectation that they are appropriate to a large majority of the students. They are stated at the grade where they are expected to be "mastered". There may be some time delays between where students first encounter the learning and where they are expected to demonstrate knowledge of, or mastery in, that learning.

**General Outcomes**

General outcomes are general statements that identify what students are expected to know and to be able to do upon completion of a grade.

**Specific Outcomes**

Specific outcomes are statements identifying the component knowledge, skills and attitudes of a general outcome.

## INSTRUCTIONAL FOCUS

Each of the four strands is of significance. Therefore, considerable time should be spent on the concepts and processes identified in each strand.

Several additional considerations are important:

- Integration of the mathematical processes, within each strand, is encouraged and expected. A coding system with references to the seven mathematical processes appears after each specific outcome.

- By decreasing emphasis on rote calculation, drill and practice, and the size of numbers used in paper and pencil calculations, more time is available for concept development.

- Problem solving, reasoning and connections are vital to increasing mathematical power and must be integrated throughout the program. A minimum of half the available time within all strands needs to be dedicated to activities related to these processes.

- There is to be a balance between estimation and mental mathematics, paper and pencil exercises and the appropriate use of technology, including calculators and computers. Concepts should be introduced, using manipulatives, and gradually developed from the concrete to the pictorial to the symbolic.

Strand: Number (Number Concepts)

*Students will:*

- use numbers to describe quantities
- represent numbers in multiple ways.

| | | | |
|---|---|---|---|
| C | Communication | PS | Problem Solving |
| CN | Connections | R | Reasoning |
| E | Estimation and Mental Mathematics | T | Technology |
| | | V | Visualization |

| Grade 6 | Grade 7 |
|---|---|
| **General Outcome**<br><br>Develop a number sense for decimals and common fractions, explore integers, and show number sense for whole numbers. | **General Outcome**<br><br>Demonstrate a number sense for decimals and integers, including whole numbers. |
| **Specific Outcomes**<br><br>1. Read and write numerals greater than a million. [C, CN]<br>2. Estimate quantities up to a million. [E]<br>3. Distinguish among, and find, multiples, factors, composites and primes, using numbers 1 to 100. [R]<br>4. Recognize, model, identify, find and describe common multiples, common factors, least common multiple, greatest common factor and prime factorization, using numbers 1 to 100. [C, PS, R, V]<br>5. Explain the meaning of integers by extending counting numbers to less than zero. [R]<br>6. Identify practical applications of integers. [CN, PS]<br>7. Read and write numbers to thousandths. [C, CN, V]<br>8. Round numbers to the nearest unit, tenth and hundredth. [E]<br>9. Demonstrate and explain the meaning of improper fractions and mixed numbers (positive) concretely, pictorially and symbolically. [C, R, V]<br>10. Demonstrate and explain the meaning of ratio concretely, pictorially and symbolically. [C, CN, R, V]<br>11. Demonstrate and explain the meaning of percentage concretely, pictorially and symbolically. [C, CN, R, V] | **Specific Outcomes**<br><br>1. Define and use power, base and exponent to represent repeated multiplication. [C, T, V]<br>2. Write a whole number as:<br>• an expanded numeral, using powers of 10<br>• scientific notation, and vice versa.<br>[C, CN, V]<br>3. Use divisibility rules to determine if a number is divisible by 2, 3, 4, 5, 6, 9, 10. [CN, R]<br>4. Read and write numbers to any number of decimal places. [C, CN, V]<br>5. Demonstrate and describe equivalent mixed numbers and improper fractions concretely, pictorially and symbolically. [C, R, V]<br>6. Compare and/or order improper fractions, mixed numbers and decimals to thousandths. [R, T, V]<br>7. Recognize and illustrate that all fractions and mixed numbers can be represented in decimal form (include terminating and repeating decimals). [R, V]<br>8. Convert from terminating decimals to fractions. [R]<br>9. Convert from single-digit repeater ( $0.\dot{3}$ ) decimal numbers to fractions, using patterns. [CN, R, V]<br>10. Demonstrate, concretely and pictorially, that the sum of opposite integers is zero. [R, V]<br>11. Represent integers in a variety of concrete, pictorial and symbolic ways. [R, V]<br>12. Compare and order integers. [R, V] |

Strand: Number (Number Concepts)

*Students will:*

- use numbers to describe quantities
- represent numbers in multiple ways.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

## Grade 8

**General Outcome**

Demonstrate a number sense for rational numbers, including common fractions, integers and whole numbers.

**Specific Outcomes**

1. Demonstrate and explain the meaning of a negative exponent, using patterns (limit to base 10). [C, CN, R, V]
2. Represent any number in scientific notation. [R]
3. Define, compare and order any rational numbers. [R, T, V]
4. Demonstrate concretely, pictorially and symbolically that the product of reciprocals is equal to 1. [R, V]
5. Express 3-term ratios in equivalent forms. [CN]
6. Represent and apply fractional per cents, and per cents greater than 100, in fraction or decimal form, and vice versa. [CN, R]
7. Represent square roots concretely, pictorially and symbolically. [R, V]
8. Distinguish between a square root and its decimal approximation as it appears on a calculator. [T]

## Grade 9

**General Outcome**

Explain and illustrate the structure and the interrelationship of the sets of numbers within the rational number system.

**Specific Outcomes**

1. Give examples of numbers that satisfy the conditions of natural, whole, integral and rational numbers, and show that these numbers comprise the rational number system. [C, CN, PS, R]
2. Describe, orally and in writing, whether or not a number is rational. [C, R]
3. Give examples of situations where answers would involve the positive (principal) square root, or both positive and negative square roots of a number. [C, CN, PS, R]

**General Outcome**

Develop a number sense of powers with integral exponents and rational bases.

**Specific Outcomes**

4. Illustrate power, base, coefficient and exponent, using rational numbers or variables as bases or coefficients. [R, V]
5. Explain and apply the exponent laws for powers with integral exponents:

$$(x^m)(x^n) = x^{m+n}$$

$$x^m \div x^n = x^{m-n}$$

$$(x^m)^n = x^{mn}$$

$$(xy)^m = x^m y^m$$

$$\left(\frac{x}{y}\right)^n = \frac{x^n}{y^n},\ y \neq 0$$

$$x^0 = 1,\ x \neq 0$$

$$x^{-n} = \frac{1}{x^n},\ x \neq 0$$

[PS, R]

6. Determine the value of powers with integral exponents, using the exponent laws. [PS, R]

Strand: Number (Number Operations)

*Students will:*

- demonstrate an understanding of and proficiency with calculations
- decide which arithmetic operation or operations can be used to solve a problem and then solve the problem.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 6 | Grade 7 |
|---|---|
| **General Outcome**<br><br>Apply arithmetic operations on whole numbers and decimals in solving problems.<br><br>**Specific Outcomes**<br><br>12. Solve problems that involve arithmetic operations on decimals to thousandths, using appropriate technology (2-digit whole number multipliers and dividers). [PS, R, T]<br>13. Estimate the solution to calculations involving whole numbers and decimals (2-digit whole number multipliers and divisors). [E, PS, R]<br>14. Use a variety of methods to solve problems with multiple solutions. [PS, R, T, V] | **General Outcome**<br><br>Apply arithmetic operations on decimals and integers, and illustrate their use in solving problems.<br><br>**Specific Outcomes**<br><br>13. Use patterns, manipulatives and diagrams to demonstrate the concepts of multiplication and division by a decimal. [CN, PS, R, V]<br>14. Use estimation strategies to justify or assess the reasonableness of calculations. [E, PS]<br>15. Add, subtract, multiply and divide decimals (for more than 2-digit divisors or multipliers, the use of technology is expected). [E, PS, T]<br>16. Add, subtract, multiply and divide integers concretely, pictorially and symbolically. [PS, V]<br>17. Illustrate and explain the order of operations, using paper and pencil or a calculator. [PS, T, V] |
| | **General Outcome**<br><br>Illustrate the use of rates, ratios, percentages and decimals in solving problems.<br><br>**Specific Outcomes**<br><br>18. Estimate and calculate percentages. [E, PS]<br>19. Distinguish between rate and ratio, and use them to solve problems. [PS]<br>20. Explain, demonstrate and use proportion in solving problems. [C, PS, V]<br>21. Convert, mentally, among fractions, decimals and per cents to facilitate the solution of problems. [E, PS] |

Strand: Number (Number Operations)

*Students will:*

- demonstrate an understanding of and proficiency with calculations
- decide which arithmetic operation or operations can be used to solve a problem and then solve the problem.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 8 | Grade 9 |
|---|---|
| **General Outcome**<br>Apply arithmetic operations on rational numbers to solve problems.<br>**Specific Outcomes**<br>9. Add, subtract, multiply and divide fractions concretely, pictorially and symbolically. [E, PS, V]<br>10. Estimate, compute and verify the sum, difference, product and quotient of rational numbers, using only decimal representations of negative rationals. [E, PS, T]<br>11. Estimate, compute (using a calculator) and verify approximate square roots of whole numbers and of decimals. [E, PS, T] | **General Outcome**<br>Use a scientific calculator or a computer to solve problems involving rational numbers.<br>**Specific Outcomes**<br>7. Document and explain the calculator keying sequences used to perform calculations involving rational numbers. [C, PS, T]<br>8. Solve problems, using rational numbers in meaningful contexts. [CN, PS] |
| **General Outcome**<br>Apply the concepts of rate, ratio, percentage and proportion to solve problems in meaningful contexts.<br>**Specific Outcomes**<br>12. Use concepts of rate, ratio, proportion and per cent to solve problems in meaningful contexts. [E, PS, T]<br>13. Calculate combined percentages in a variety of meaningful contexts. [CN, E, PS, T]<br>14. Derive and apply unit rates. [PS, R]<br>15. Express rates and ratios in equivalent forms. [PS, R] | **General Outcome**<br>Explain how exponents can be used to bring meaning to large and small numbers, and use calculators or computers to perform calculations involving these numbers.<br>**Specific Outcomes**<br>9. Understand and use the exponent laws to simplify expressions with variable bases and evaluate expressions with numerical bases. [PS, R]<br>10. Use a calculator to perform calculations involving scientific notation and exponent laws. [PS, R, T] |

Strand: Patterns and Relations (Patterns)

*Students will:*

- use patterns to describe the world and to solve problems.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 6 | Grade 7 |
|---|---|
| **General Outcome**<br><br>Use relationships to summarize, generalize and extend patterns, including those found in music and art.<br><br>**Specific Outcomes**<br><br>1. Represent, visually, a pattern to clarify relationships and to verify predictions. [C, R, V]<br>2. Summarize a relationship, using everyday language in spoken or written form. [C, R]<br>3. Create expressions and rules to describe, complete and extend patterns and relationships. [C, CN, PS, R]<br>4. Find approximate number values from a given graph. [PS, R] | **General Outcome**<br><br>Express patterns, including those used in business and industry, in terms of variables, and use expressions containing variables to make predictions.<br><br>**Specific Outcomes**<br><br>1. Predict and justify possible *n*th values of a number pattern. [C, CN, R]<br>2. Interpolate and extrapolate number values from a given graph. [E, PS, V]<br>3. Graph relations, analyze the result and draw a conclusion from a pattern. [R, V]<br>4. Use patterns and relations to represent simple oral and written expressions as mathematical symbols, and vice versa. [CN, PS, R] |

Strand: Patterns and Relations (Patterns)

*Students will:*

- use patterns to describe the world and to solve problems.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 8 | Grade 9 |
|---|---|
| **General Outcome**<br><br>Use patterns, variables and expressions, together with their graphs, to solve problems.<br><br>**Specific Outcomes**<br><br>1. Generalize a pattern arising from a problem-solving context, using mathematical expressions and equations, and verify by substitution. [C, CN, PS, R]<br>2. Substitute numbers for variables in expressions, and graph and analyze the relation. [C, PS, R, V]<br>3. Translate between an oral or written expression and an equivalent algebraic expression. [C, CN] | **General Outcome**<br><br>Generalize, design and justify mathematical procedures, using appropriate patterns, models and technology.<br><br>**Specific Outcomes**<br><br>1. Use logic and divergent thinking to present mathematical arguments in solving problems. [C, PS, R]<br>2. Model situations that can be represented by first-degree expressions. [CN, PS]<br>3. Write equivalent forms of algebraic expressions, or equations, with rational coefficients. [C, CN, R] |

Strand: Patterns and Relations (Variables and Equations)

*Students will:*

- represent algebraic expressions in multiple ways.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 6 | Grade 7 |
|---|---|
| **General Outcome**<br><br>Use informal and concrete representations of equality and operations on equality to solve problems.<br><br>**Specific Outcomes**<br><br>5. Demonstrate and explain the meaning and preservation of equality by balancing objects, or by using models and diagrams. [C, CN, PS, R, V]<br>6. Use pre-algebra strategies to solve equations with one unknown and with whole number coefficients and solutions. [PS, R] | **General Outcome**<br><br>Use variables and equations to express, summarize and apply relationships as problem-solving tools in a restricted range of contexts.<br><br>**Specific Outcomes**<br><br>5. Write mathematical expressions that arise from problem-solving contexts. [C, CN, PS]<br>6. Evaluate expressions with and without concrete models. [R, V]<br>7. Illustrate the solution process for a one-step, single-variable, first-degree equation, using concrete materials or diagrams. [CN, PS, V]<br>8. Solve and verify one-step linear equations, using a variety of techniques. [PS, R]<br>9. Explain how to solve simple problems, using informal algebraic methods. [C, PS, R] |

Strand: Patterns and Relations (Variables and Equations)

*Students will:*

- represent algebraic expressions in multiple ways.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

## Grade 8

**General Outcome**

Solve and verify one-step and two-step linear equations with rational number solutions.

**Specific Outcomes**

4. Illustrate the solution process for a two-step, single-variable, first-degree equation, using concrete materials or diagrams. [CN, PS, V]
5. Solve and verify one- and two-step, first-degree equations of the form:
   - $x + a = b$
   - $ax = b$
   - $\frac{x}{a} = b$
   - $ax + b = c$
   - $\frac{x}{a} + b = c$

   where $a$, $b$ and $c$ are integers. [PS, V]
6. Create and solve problems, using first-degree equations. [PS]

## Grade 9

**General Outcome**

Solve and verify linear equations and inequalities in one variable.

**Specific Outcomes**

4. Illustrate the solution process for a first-degree, single-variable equation, using concrete materials or diagrams. [PS, R, V]
5. Solve and verify first-degree, single-variable equations of forms, such as:
   - $ax = b + cx$
   - $a(x + b) = c$
   - $ax + b = cx + d$
   - $a(bx + c) = d(ex + f)$
   - $\frac{a}{x} = b$

   where $a$, $b$, $c$, $d$, $e$ and $f$ are all rational numbers (with a focus on integers), and use equations of this type to model and solve problem situations. [C, PS, V]
6. Solve, algebraically, first-degree inequalities in one variable, display the solutions on a number line and test the solutions. [PS, R, V]

**General Outcome**

Generalize arithmetic operations from the set of rational numbers to the set of polynomials.

**Specific Outcomes**

7. Identify constant terms, coefficients and variables in polynomial expressions. [C]
8. Evaluate polynomial expressions, given the value(s) of the variable(s). [E]
9. Represent and justify the addition and subtraction of polynomial expressions, using concrete materials and diagrams. [C, R, V]
10. Perform the operations of addition and subtraction on polynomial expressions. [R]
11. Represent multiplication, division and factoring of monomials, binomials, and trinomials of the form $x^2 + bx + c$, using concrete materials and diagrams. [R, V]
12. Find the product of two monomials, a monomial and a polynomial, and two binomials. [R]
13. Determine equivalent forms of algebraic expressions by identifying common factors and factoring trinomials of the form $x^2 + bx + c$. [PS, R]
14. Find the quotient when a polynomial is divided by a monomial. [R]

Strand: Shape and Space (Measurement)

*Students will:*

- describe and compare everyday phenomena, using either direct or indirect measurement.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 6 | Grade 7 |
|---|---|
| **General Outcome**<br><br>Solve problems involving perimeter, area, surface area, volume and angle measurement.<br><br>**Specific Outcomes**<br><br>1. Use conversions among commonly used SI units of length, mass (weight) and capacity (volume) to solve problems. [E, PS]<br>2. Develop, verify and use rules or expressions for the perimeter of polygons. [CN, PS, R]<br>3. Develop, verify and apply rules or expressions for the area of rectangles ($mm^2$, $cm^2$, $m^2$, ha and $km^2$). [CN, PS, R]<br>4. Estimate and determine the surface area of a right rectangular prism, without using a formula. [E, PS]<br>5. Discover, generalize and use rules for the volume of right rectangular prisms. [PS, R]<br>6. Design and construct rectangles, given one or both of perimeter and area, using whole numbers. [PS, R]<br>7. Demonstrate concretely, pictorially and symbolically that many rectangles are possible for a given perimeter or a given area. [CN, R]<br>8. Determine the volume of an object by measuring the displacement of a liquid by that object ($cm^3$ or mL). [PS, R]<br>9. Recognize angles as being more than 90 degrees, equal to 90 degrees, less than 90 degrees, equal to 180 degrees, greater than 180 degrees. [V]<br>10. Estimate and measure angles, using a circular protractor. [E]<br>11. Sketch and draw an angle when the degree measure is specified. [E, V]<br>12. Classify given angles as acute, right, obtuse, straight and reflex. [E]<br>13. Identify and compare examples of angles in the environment. [CN, V] | **General Outcome**<br><br>Solve problems involving the properties of circles and their connections with angles and time zones.<br><br>**Specific Outcomes**<br><br>1. Measure the diameters, radii and circumferences of circles, and establish the relationships among them. [CN, R]<br>2. Solve problems involving the radii, diameters and circumferences of circles. [PS, T]<br>3. Explain how time zones are determined. [C, PS]<br>4. Research and report how measurement instruments are used in the community. [C, CN] |

Strand: Shape and Space (Measurement)

*Students will:*

- describe and compare everyday phenomena, using either direct or indirect measurement.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 8 | Grade 9 |
|---|---|
| **General Outcome**<br>Apply indirect measurement procedures to solve problems.<br>**Specific Outcomes**<br>1. Use concrete materials and diagrams to develop the Pythagorean relationship. [CN, R]<br>2. Use the Pythagorean relationship to calculate the measure of the third side, of a right triangle, given the other two sides in 2-D applications. [PS] | **General Outcome**<br>Use trigonometric ratios to solve problems involving a right triangle.<br>**Specific Outcomes**<br>1. Explain the meaning of sine, cosine and tangent ratios in right triangles. [C]<br>2. Demonstrate the use of trigonometric ratios (sine, cosine and tangent) in solving right triangles. [PS]<br>3. Calculate an unknown side or an unknown angle in a right triangle, using appropriate technology. [PS, T]<br>4. Model and then solve given problem situations involving only one right triangle. [PS, T, V] |
| **General Outcome**<br>Generalize measurement patterns and procedures, and solve problems involving area, perimeter, surface area and volume.<br>**Specific Outcomes**<br>3. Describe patterns, and generalize the relationships by determining the areas and perimeters of quadrilaterals and the areas and circumferences of circles. [C, CN, PS, T]<br>4. Estimate, measure and calculate the surface area and volume of any right prism or cylinder. [E, PS, T]<br>5. Estimate and calculate the area of composite figures. [E, PS, R]<br>6. Estimate, measure and calculate the surface area of composite 3-D objects. [E, PS, R]<br>7. Estimate, measure and calculate the volume of composite 3-D objects. [E, PS, R] | **General Outcome**<br>Describe the effects of dimension changes in related 2-D shapes and 3-D objects in solving problems involving area, perimeter, surface area and volume.<br>**Specific Outcomes**<br>5. Relate expressions for volumes of pyramids to volumes of prisms, and volumes of cones to volumes of cylinders. [CN, R]<br>6. Calculate and apply the rate of volume to surface area to solve design problems in three dimensions. [PS, T, V]<br>7. Calculate and apply the rate of area to perimeter to solve design problems in two dimensions. [PS, T, V] |

Strand: Shape and Space (3-D Objects and 2-D Shapes)

*Students will:*

- describe the characteristics of 3-D objects and 2-D shapes, and analyze the relationships among them.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 6 | Grade 7 |
|---|---|
| **General Outcome**<br><br>Use visualization and symmetry to solve problems involving classification and sketching.<br><br>**Specific Outcomes**<br><br>14. Classify triangles according to the measures of their angles. [C, E]<br>15. Sort quadrilaterals and regular polygons according to the number of lines of symmetry. [V]<br>16. Reproduce a given geometric drawing on grid paper. [V]<br>17. Sketch 3-D solids and skeletons with and without grids. [PS, T, V]<br>18. Recognize and appreciate optical illusions. [V] | **General Outcome**<br><br>Link angle measures to the properties of parallel lines.<br><br>**Specific Outcomes**<br><br>5. Measure and classify pairs of angles as complementary or supplementary angles. [E]<br>6. Investigate, identify and name pairs of angles pertaining to parallel lines and transversals, including:<br>• corresponding<br>• vertically opposite<br>• interior on the same side of the transversal<br>• exterior on the same side of the transversal<br>• alternate angles.<br>[C, V]<br>7. Describe the relationships between the pairs of angles pertaining to parallel lines and transversals. [C, R, T]<br>8. Explain, in more than one way, why the sum of the measures of the angles of a triangle is 180°. [C, R, T]<br>9. Use mathematical reasoning to determine the measures of angles in a diagram. [R, V]<br>10. Construct angle bisectors and perpendicular bisectors. [R, T, V] |

Strand: Shape and Space (3-D Objects and 2-D Shapes)

*Students will:*

- describe the characteristics of 3-D objects and 2-D shapes, and analyze the relationships among them.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 8 | Grade 9 |
|---|---|
| **General Outcome**<br><br>Link angle measures and the properties of parallel lines to the classification and properties of quadrilaterals.<br><br>**Specific Outcomes**<br><br>8. Identify, investigate and classify quadrilaterals, regular polygons and circles, according to their properties. [PS, R, T]<br>9. Build 3-D objects from a variety of representations (nets, skeletons). [PS, V] | **General Outcome**<br><br>Specify conditions under which triangles may be similar or congruent, and use these conditions to solve problems.<br><br>**Specific Outcomes**<br><br>8. Recognize when, and explain why, two triangles are similar, and use the properties of similar triangles to solve problems. [C, PS, R, T]<br>9. Recognize when, and explain why, two triangles are congruent, and use the properties of congruent triangles to solve problems. [C, CN, PS, R, T]<br>10. Relate congruence to similarity in the context of triangles. [CN, R] |
| | **General Outcome**<br><br>Use spatial problem solving in building, describing and analyzing geometric shapes.<br><br>**Specific Outcomes**<br><br>11. Draw the plan and elevations of a 3-D object from sketches and models. [C, R, T, V]<br>12. Sketch or build a 3-D object, given its plan and elevation views. [C, PS, T, V]<br>13. Recognize and draw the locus of points in solving practical problems. [PS, T, V] |

Strand: Shape and Space (Transformations)
*Students will:*
- perform, analyze and create transformations.

| | | | |
|---|---|---|---|
| C | Communication | PS | Problem Solving |
| CN | Connections | R | Reasoning |
| E | Estimation and Mental Mathematics | T | Technology |
| | | V | Visualization |

| Grade 6 | Grade 7 |
|---|---|
| **General Outcome**<br>Create patterns and designs that incorporate symmetry, tessellations, translations and reflections.<br><br>**Specific Outcomes**<br>19. Create, analyze and describe designs, using translations (slides) and reflections (flips). [C, T, V]<br>20. Draw designs, using ordered pairs, in the first quadrant of the coordinate grid. [PS, V] | **General Outcome**<br>Create and analyze patterns and designs, using congruence, symmetry, translation, rotation and reflection.<br><br>**Specific Outcomes**<br>11. Create, analyze and describe designs, using translations (slides), rotations (turns) and reflections (flips). [C, T, V]<br>12. Use informal concepts of congruence to describe images after translations, rotations and reflections. [C, T]<br>13. Draw designs, using ordered pairs, in all four quadrants of the coordinate grid, together with translation and reflection images. [PS, V]<br>14. Relate reflections to lines and planes of symmetry. [CN, V] |

Strand: Shape and Space (Transformations)
*Students will:*
- perform, analyze and create transformations.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 8 | Grade 9 |
|---|---|
| **General Outcome**<br><br>Create and analyze design problems and architectural patterns, using the properties of scaling, proportion and networks.<br><br>**Specific Outcomes**<br><br>10. Represent, analyze and describe enlargements and reductions. [CN, R]<br>11. Draw and interpret scale diagrams. [PS, T]<br>12. Represent, analyze and describe regions and colouring problems. [C, PS, V]<br>13. Describe, analyze and solve network problems; e.g., bus routes, a telephone exchange. [C, E, PS] | **General Outcome**<br><br>Apply coordinate geometry and pattern recognition to predict the effects of translations, rotations, reflections and dilatations on 1-D lines and 2-D shapes.<br><br>**Specific Outcomes**<br><br>14. Draw the image of a 2-D shape as a result of:<br>• a single transformation<br>• a dilatation<br>• combinations of translations and/or reflections.<br>[PS, T, V]<br>15. Identify the single transformation that connects a shape with its image. [R]<br>16. Demonstrate that a triangle and its dilatation image are similar. [R]<br>17. Demonstrate the congruence of a triangle with its:<br>• translation image<br>• rotation image<br>• reflection image.<br>[R] |

Strand: Statistics and Probability (Data Analysis)

*Students will:*

- collect, display and analyze data to make predictions about a population.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 6 | Grade 7 |
|---|---|
| **General Outcome**<br><br>Develop and implement a plan for the collection, display and analysis of data gathered from appropriate samples.<br><br>**Specific Outcomes**<br><br>1. Formulate questions for investigation, given a context. [C, CN, R]<br>2. Identify appropriate data sources: first-hand, second-hand and combination. [R]<br>3. Select and use appropriate methods of collecting data:<br>• designing and using structured questionnaires<br>• experiments<br>• observations<br>• electronic networks.<br>[C, PS, T]<br>4. Select and defend the choice of an appropriate sample or population to be used to answer a question. [C, R]<br>5. Discuss how collected data are affected by the nature of the sample, the method of collection, the sample size and biases. [C, CN]<br>6. Display data by hand or by computer in a variety of ways, including:<br>• histograms<br>• double bar graphs<br>• stem and leaf plots.<br>[C, T, V]<br>7. Read and interpret graphs that are provided. [C, E, PS, R]<br>8. Describe the general distribution of data, using:<br>• smallest and largest value<br>• frequency<br>• value in the middle<br>• patterns.<br>[C, CN]<br>9. Analyze sets of data to make comparisons. [E, PS, R] | **General Outcome**<br><br>Develop and implement a plan for the collection, display and analysis of data, using measures of variability and central tendency.<br><br>**Specific Outcomes**<br><br>1. Formulate questions for investigation, from a real-world context. [C, CN, R]<br>2. Select, defend and use appropriate methods of collecting data:<br>• designing and using questionnaires<br>• interviews<br>• experiments<br>• research.<br>[C, PS, T]<br>3. Describe issues to be considered when collecting data; e.g., appropriate language, ethics, cost, privacy, cultural sensitivity. [C, CN, R]<br>4. Display data by hand or by computer in a variety of ways, including circle graphs. [C, T, V]<br>5. Read and interpret graphs. [C, E, PS, R]<br>6. Determine measures of central tendency for a set of data:<br>• mode<br>• median<br>• mean.<br>[PS]<br>7. Determine measures of the distribution of a set of data:<br>• range<br>• extremes, gaps and clusters<br>• quartiles.<br>[PS]<br>8. Interpolate from data to make predictions. [E, PS, R] |

Strand: Statistics and Probability (Data Analysis)

*Students will:*

- collect, display and analyze data to make predictions about a population.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

## Grade 8

**General Outcome**

Develop and implement a plan for the collection, display and analysis of data, using technology, as required.

**Specific Outcomes**

1. Formulate questions for investigation, using existing data. [C, CN, R]
2. Select, defend and use appropriate methods of collecting data:
   - designing and using surveys
   - research, using electronic media.

   [C, PS, T]
3. Display data by hand or by computer in a variety of ways, including box and whisker plots. [C, T, V]

**General Outcome**

Evaluate and use measures of central tendency and variability.

**Specific Outcomes**

4. Determine and use the most appropriate measure of central tendency in a given context. [CN, PS, T]
5. Describe the variability of data sets, using such techniques as range, and box and whisker plots. [C, PS, T]
6. Construct sets of data given measures of central tendency and variability. [PS, R]
7. Determine the effect on the mean, median and/or mode when:
   - a constant is added or subtracted from each value
   - each value is multiplied or divided by the same constant
   - a significantly different value is included.

   [E, PS, R]

## Grade 9

**General Outcome**

Collect and analyze experimental results expressed in two variables, using technology, as required.

**Specific Outcomes**

1. Design, conduct and report on an experiment to investigate a relationship between two variables. [C, CN, PS]
2. Create scatterplots for discrete and continuous variables. [C, V]
3. Interpret a scatterplot to determine if there is an apparent relationship. [E, R]
4. Determine the lines of best fit from a scatterplot for an apparent linear relationship, by:
   - inspection
   - using technology (equations are not expected).

   [E, PS, T]
5. Draw and justify conclusions from the line of best fit. [C, R]
6. Assess the strengths, weaknesses and biases of samples and data collection methods. [C, R, T]
7. Critique ways in which statistical information and conclusions are presented by the media and other sources. [C, CN]

Strand: Statistics and Probability (Chance and Uncertainty)

*Students will:*

- use experimental or theoretical probability to represent and solve problems involving uncertainty.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 6 | Grade 7 |
|---|---|
| **General Outcome**<br><br>Use numbers to communicate the probability of single events from experiments and models.<br><br>**Specific Outcomes**<br><br>10. Distinguish between experimental and theoretical probability for single events. [PS, R]<br>11. Make the connection between the number of faces, for various dice, and the probability of a single event. [CN, R]<br>12. Calculate theoretical probability, using numbers between 0 and 1. [E, PS]<br>13. Demonstrate that different outcomes may occur when repeating the same experiment. [PS, T]<br>14. Compare experimental results with theoretical results. [C, E, R] | **General Outcome**<br><br>Create and solve problems, using probability.<br><br>**Specific Outcomes**<br><br>9. Use a table to identify all possible outcomes of two independent events. [PS, R]<br>10. Create and solve problems, using the numerical definition of probability as favourable outcomes divided by possible outcomes. [PS, R]<br>11. Use the Monte Carlo simulation method to solve probability problems. [CN, E, PS, T] |

Strand: Statistics and Probability (Chance and Uncertainty)

*Students will:*

- use experimental or theoretical probability to represent and solve problems involving uncertainty.

| | | | |
|---|---|---|---|
| **C** | Communication | **PS** | Problem Solving |
| **CN** | Connections | **R** | Reasoning |
| **E** | Estimation and Mental Mathematics | **T** | Technology |
| | | **V** | Visualization |

| Grade 8 | Grade 9 |
|---|---|
| **General Outcome**<br><br>Compare theoretical and experimental probability of independent events.<br><br>**Specific Outcomes**<br><br>8. Use computer or other simulations to solve probability and data collection problems. [E, PS, T]<br>9. Recognize that if $n$ events are equally likely the probability of any one of them occurring is $\frac{1}{n}$. [R]<br>10. Determine the probability of two independent events where the combined sample space has 52 or fewer elements. [PS, R, V]<br>11. Predict population characteristics from sample data. [C, CN] | **General Outcome**<br><br>Explain the use of probability and statistics in the solution of complex problems.<br><br>**Specific Outcomes**<br><br>8. Recognize that decisions based on probability may be a combination of theoretical calculations, experimental results and subjective judgements. [PS, R]<br>9. Demonstrate an understanding of the role of probability and statistics in society. [C, CN]<br>10. Solve problems involving the probability of independent events. [PS, T] |

## REFERENCES

American Association for the Advancement of Science [AAAS–Benchmarks]. *Benchmark for Science Literacy.* New York, NY: Oxford University Press, 1993.

Armstrong, Thomas. *Seven Kinds of Smart: Identifying and Developing Your Many Intelligences.* New York, NY: NAL-Dutton, 1993.

Caine, Renate Nummela and Geoffrey Caine. *Making Connections: Teaching and the Human Brain.* Menlo Park, CA: Addison-Wesley Publishing Company, 1991.

Hope, Jack. *Charting the Course, A Guide for Revising the Mathematics Program in the Province of Saskatchewan.* Regina, SK: Saskatchewan Instructional Development and Research Unit, Faculty of Education [SIDRU]. University of Regina, 1990.

National Council of Teachers of Mathematics. *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA: [NCTM], 1989.

Steen, Lynn Arthur (ed). *On the Shoulders of Giants, New Approaches to Numeracy.* Washington, DC: National Academy Press, 1990.